Marwari college Darbhanga

Subject---physics (Sub)

Class—B.Sc. part 2

Group—C

Topic—Nuclear physics (Nucleus and it's structure)

Lacture series---01

By:- DR. SONY KUMARI,

Assistant professor

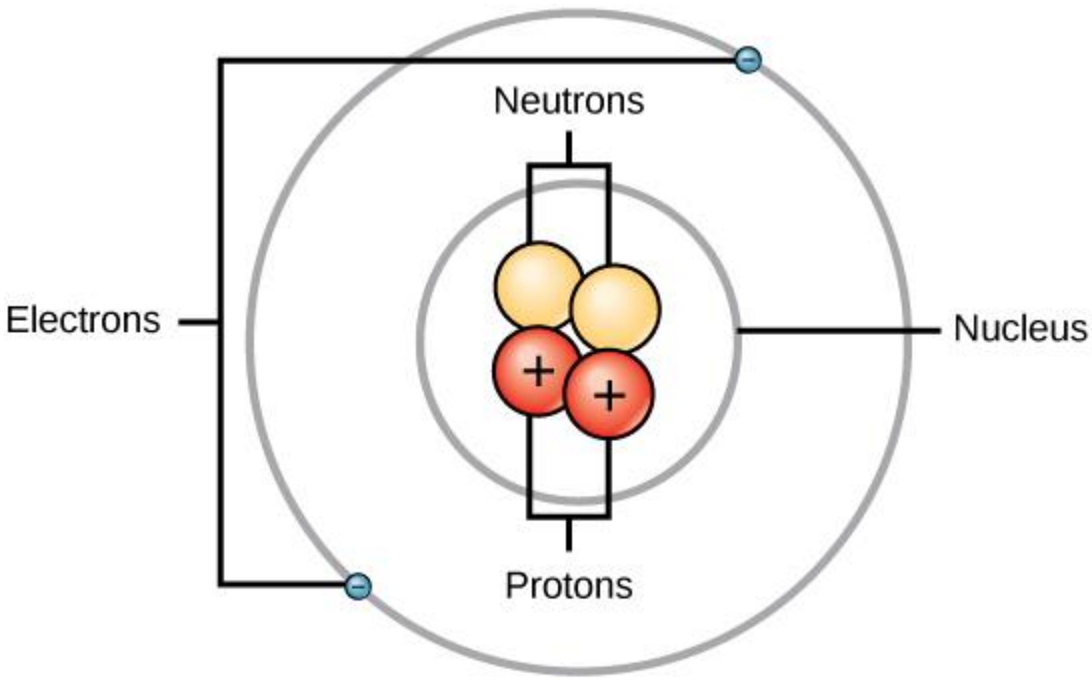
Marwari college Darbhanga

Nucleus and it's structure

Atomic structure

Atoms consist of three basic particles: protons, electrons, and neutrons. The nucleus (center) of the atom contains the protons (positively charged) and the neutrons (no charge). The outermost regions of the atom are called electron shells and contain the electrons (negatively charged). Atoms have different properties based on the arrangement and number of their basic particles.

The hydrogen atom (H) contains only one proton, one electron, and no neutrons. This can be determined using the atomic number and the mass number of the element (see the concept on atomic numbers and mass numbers).



The Nucleus

The **atomic nucleus** is the central area of the atom. It is composed of two kinds of subatomic particles: protons and neutrons.

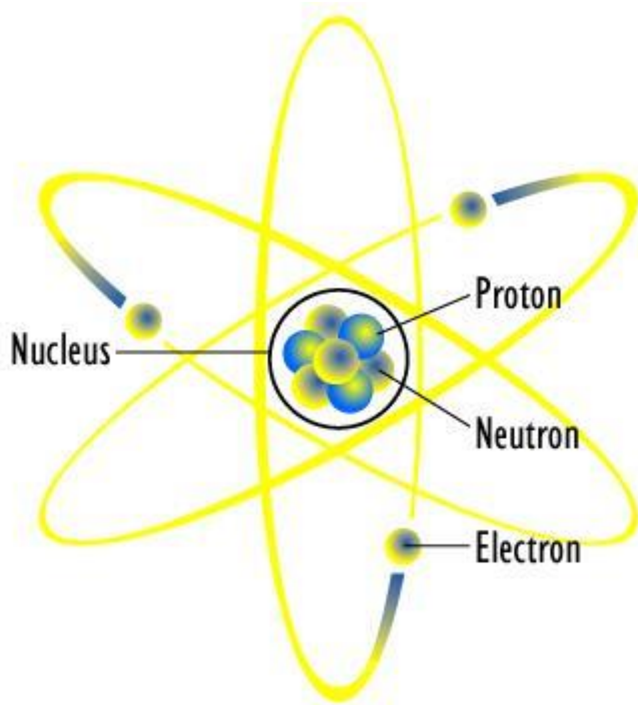


Diagram showing the atomic structure with the protons and neutrons held together to form the dense area of the nucleus

Atoms are the building blocks of all matter. Everything you can see, feel and touch is all made of atoms. There are even things you cannot see, feel, hear or touch that are also made of atoms. Basically, everything is made up of atoms.

Atomic Numbers

The atomic nucleus is in the center of the atom. The number of protons and neutrons in the atom define what type of atom or element it is. An **element** is a bunch of atoms that all have the same type of atomic structure. For instance, hydrogen is an element.

The composition of the atomic nucleus gives us lots of information about the element it represents. The number of protons inside the nucleus gives us the **atomic number**. The **protons** have a positive (+) charge. In order for the atom to have a neutral charge, the electrons (-) need to balance it out with their negative charge. Therefore, in a **neutral atom** there are just as many protons as electrons. So, if you know the atomic number and know the charge of the atom then the number of electrons is easy to find

Atomic Mass

Protons and neutrons have approximately the same mass, about 1.67×10^{-24} grams. Scientists define this amount of mass as one atomic mass unit (amu) or one Dalton. Although similar in mass, protons are positively charged, while neutrons have no charge. Therefore, the number of neutrons in an atom contributes significantly to its mass, but not to its charge.

Binding Energy

Nuclear binding energy is the energy required to split a nucleus of an atom into its component parts: protons and neutrons, or, collectively, the nucleons. The binding energy of nuclei is always a positive number, since all nuclei require net energy to separate them into individual protons and neutrons.

Nuclear binding energy is the *minimum* energy that would be required to disassemble the nucleus of an atom into its component parts. These component parts are neutrons and protons, which are collectively called nucleons. The binding energy is always a positive number, as we need to spend energy in moving these nucleons, attracted to each other by the strong nuclear force, away from each other. The mass of an atomic nucleus is less than the sum of the individual masses of the free constituent protons and neutrons, according to Einstein's equation $E=mc^2$. This 'missing mass' is known as the **mass defect**, and represents the energy that was released when the nucleus was formed.

The term "nuclear binding energy" may also refer to the energy balance in processes in which the nucleus splits into fragments composed of more than one nucleon. If new binding energy is available when light nuclei fuse (nuclear fusion), or when heavy nuclei split (nuclear fission), either process can result in release of this binding energy. This energy may be made available as *nuclear energy* and can be used to produce electricity, as in nuclear power, or in a nuclear weapon. When a large nucleus splits into pieces, excess energy is emitted as photon (gamma rays) and as the kinetic energy of a number of different ejected particles (nuclear fission products).

These nuclear binding energies and forces are on the order of a million times greater than the electron binding energies of light atoms like hydrogen

The mass defect of a nucleus represents the amount of mass equivalent to the binding energy of the nucleus ($E=mc^2$), which is the difference between the mass of a nucleus and the sum of the individual masses of the nucleons of which it is composed.